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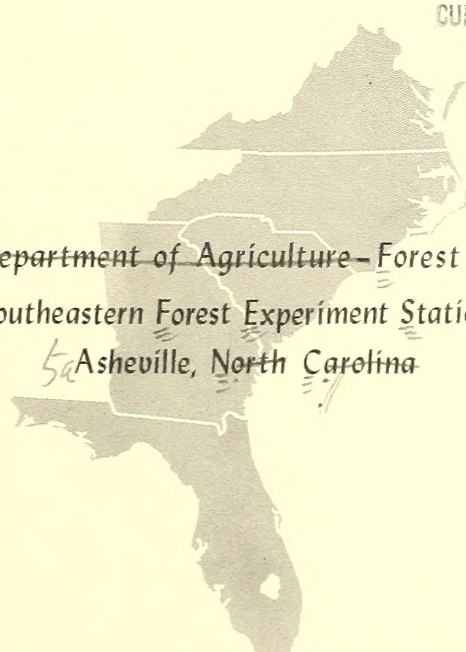

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Where to locate and how to plan, rehabilitate, and manage developed camping and picnicking sites are problems of considerable and growing import. Controversy involving aesthetics, beauty (both natural and planned), and "user satisfaction" notwithstanding, it may be assumed that preservation of the natural forest environment at some recognizable level is a desirable objective. The capacity of man to adjust to change in natural or artificial plant communities does not preclude an objective to manage the natural forest environs in a pleasing and recognizable manner--to maintain a tree cover. It perhaps is not essential to have tree growth actually within a developed site, but it may be argued that some form of tree growth and nearly complete ground cover in such sites is desirable, if for no other reason than for protection.

Dana (1957) in his problem analysis of research in forest recreation identified major fields of priority work. Among the 17 he listed, three deal directly with relations between biological and physical properties of sites, design, and use loads. Significant contributions in this field of work have been extremely limited, and work in the Southern Appalachians apparently has never been undertaken.

Wagar[1/] made a major contribution by developing predicting equations of the durability of biotic communities. His data collections and analyses from southeastern Michigan gave two prediction equations. One involved three independent variables predicting reduction in weight of vegetation. The other equation involved four independent variables and predicted the weight of vegetation clipped from treated plots. R^2 values were 0.64 and 0.95 for the two solutions, respectively. Wagar (1961) published this information and used the variables in the first solution to develop a "trampling" slide rule. Three independent variables, X_1--the percent of grass and woody vines present in low-growing vegetation before trampling; X_2--the percentage of direct sunlight blocked by shade-casting objects; and X_3--ovendry weight in

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1/ Wagar, J. A. The carrying capacity of wild lands for recreation. University of Michigan. 1961. [Unpublished Ph. D. dissertation.]

grams of low-growing vegetation, were used where Y was the weight of low-growing vegetation that survived trampling. This equation is analogous to the one Wagar reported in his dissertation, op. cit., accounting for 65 percent of the variation in treatment effects. Wagar's work served importantly in developing concepts, and showed quite clearly that this approach to an understanding of relations between vegetal characteristics and site degradation was feasible.

THE STUDY

This study was conducted, first, to identify and describe general relations between the physical and biological properties of developed sites, use loads, and degrees of site degradation; and secondly, to use these findings to aid in site selection, development, and rehabilitation.

Forty-two developed camping and picnic sites on the Cherokee, Nantahala, and Pisgah National Forests were used in this study. Areas selected were ten or more years old and contained from one to twenty-one family units (a picnic table and accessory facilities) per site. Field sampling for this work was accomplished during the summer of 1961. Data collected by the National Forests for the Outdoor Recreation Resources Review Commission on each developed site also served as an important source of information in addition to field data collections.

It was thought that the use impacts on camping areas versus picnic areas could differ considerably--with camping probably producing a much more pronounced effect. It was also suspected that soil origin might have a controlling effect on all of the measured variables. Accordingly, sites were stratified on the basis of soil origin as either transported or residual and principal use (camping and picnicking).

Samples to give information for this study of site-use relations were taken in 280 family units (in the 42 campgrounds and picnic areas selected) with picnic tables serving as centers for plots with $\frac{1}{2}$-chain radii. Definitions of all variables used in regression analysis and units of measurement are given in the following tabulation:

X_1--Outside depth of A horizon as tabulated in inches and tenths.

X_2--Hydrologic condition as recorded in relative numerical values in units or tenths based on the alignment chart (fig. 1).

X_3 and X_4--Soil textures for A and B horizons, respectively, were recorded in units, tenths, and hundredths of millimeters in particle size diameters.

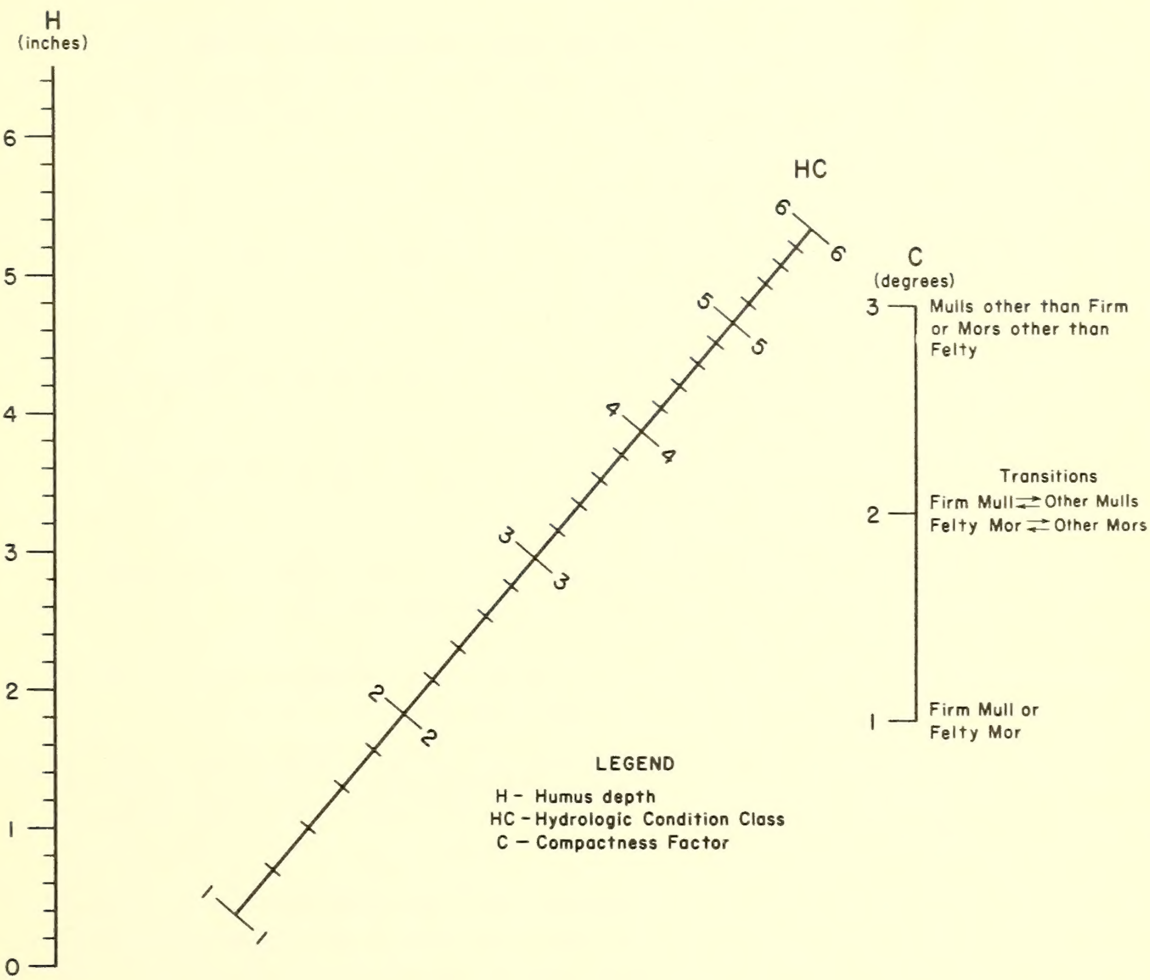


Figure 1. --Chart for determining present hydrologic condition of forest and woodland.

X_5--Aspect was transformed using a sine curve based on findings by Doolittle (1957). Associated values for aspect are:

N = 1.7	S = 0.3
NE = 2.0	SW = 0.0
E = 1.7	W = 0.3
SE = 1.0	NW = 1.0

FLAT = 1.0

X_6--Position on slope was coded using values of 0 through 1.00, corresponding to five positions--ridge, upper third, middle third, lower third, and bottom--with ascending values corresponding to general increases in site potential:

Bottom	1.00	Upper 1/3	0.25
Lower 1/3	0.75	Ridge	0.00
Middle 1/3	0.50		

X_7--Percent slope was recorded as a whole number as measured directly with an Abney hand level.

X_8--Basal area was recorded in units and tenths of square feet for each sample plot with 1-chain diameter.

X_9--Percent conifers in stand was used as the whole percentage based on the ratio of conifer to total stems.

X_{10} and X_{11}--Percent high and total canopy, respectively, were taken directly from field observations.

X_{12}--Percent shrub barrier was computed by dividing the area protected from human use by shrub cover by total area of the plot.

X_{13}--Acres per table, recorded in units and tenths, was computed using tables sampled and total acreage in the general boundary of the developed site (wherever acreage figures were not available from NFORRR 2/ observations, acreage was determined by running the boundary with a hand compass and pacing).

X_{14} and X_{15}--Distance to nearest table and distance to nearest parking were recorded in units and tenths of chains.

2/ National Forest Outdoor Recreation Resources Review.

X_{16}--Volume use per table was taken as the total number of visits estimated for the site divided by the number of tables sampled.

X_{17}--Months of use was recorded directly as a whole number taken from NFORRR data.

X_{18}--Percent slope "squared" was used as a whole number.

In addition, definitions, methods of computing, and units for analysis for the eight dependent variables are as follows:

Y_1--Percent change in depth of A horizon was computed by dividing the difference of the depth of A horizon between inside and comparable outside plot readings by outside plot readings.

Y_2--Percent change in hydrologic condition was similarly computed by dividing differences in hydrologic condition values by outside-the-plot readings.

Y_3 and Y_4--Bare ground was recorded as total percentage of bare ground, both unplanned and total, respectively.

Y_5--Percent of trees injured in each sample plot.

Y_6, Y_7, and Y_8--Degrees of erosion, root exposure, and vandalism, respectively, were taken from unit samples and were transformed for analysis as either -1 or +1, where -1 corresponds to subjective classes 1 and 2 of none or moderate, and +1 corresponds to subjective class 3, heavy.

Multiple regression solutions were generated for each Y variable for: (1) picnic sites on residual soils; (2) camping and picnicking sites on residual soils; (3) camping sites on transported soils; (4) picnicking sites on transported soils; (5) camping and picnicking sites on transported soils; and (6) all sites and all soils. All solutions for areas on residual soils used the full array of independent variables and 8 dependent variables. Analysis performed on transported soils and the summary for all sites and soils were based on 14 independent variables (X_5 through X_{18}) and 6 dependent variables (Y_3 through Y_8).

RESULTS

The results of the multiple regression analysis are shown in tables 1, 2, 3, 4, 5, and 6. Individual tables report separate values for picnicking use from camping use and residual soils from transported soils. Tables 2 and 3 give solutions for both types of recreation sites on residual and transported soils, respectively. Table 6 reports the findings for all sites on all soils. Two values are given in each cell for each significant X and Y variable combination: First is the F value, and second, the regression coefficient (b value) in the original units. An independent variable was considered significant when the F value obtained by adding it to the regression equation was greater than 3.000. Shown also in individual tables are the multiple correlation coefficients (R) and the percentage of variation in the solution explained by the variables shown (R^2 x 100). The b values represent the units of change in a Y variable associated with one unit of change in a significant X variable (except in the case of X_{16}, where volume of use is expressed per 1,000 visits). The sign of the b value indicates the direction of the slope of the regression line.

Table 1. --Regression solution for 93 picnicking sites on residual soils. Combinations of X variables yielding best solution for individual Y variables showing F values (best fit) and b values (sign and slope)

Independent variables		Y_1 Change in depth of A horizon	Y_2 Change in hydrologic condition	Y_3 Bare ground-unplanned	Y_4 Bare ground-total	Y_5 Trees injured	Y_6 Degree of erosion	Y_7 Degree of root exposure	Y_8 Degree of vandalism
X_1 Depth of A horizon	F			10.49	15.56				
	b			-11.56	-12.60				
X_2 Hydrologic condition	F		56.10	7.33	13.12	13.16			
	b		12.67	15.91	18.59	22.57			
X_3 Texture of A horizon	F			19.25	3.58	3.92	22.93		
	b			131.76	61.71	88.17	3.67		
X_4 Texture of B horizon	F	15.23	24.36		3.79				
	b	-41.88	-33.17		32.70				
X_5 Aspect	F	30.87							10.06
	b	24.68							-.49
X_6 Position on slope	F					18.78	20.66	29.83	
	b					93.10	1.51	1.10	
X_7 Slope	F						3.10		
	b						.06		
X_8 Basal area of plot	F								
	b								
X_9 Conifer component	F					3.45	5.80		
	b					-.28	-.01		
X_{10} High canopy	F		18.39	4.07	3.53		9.80	21.00	
	b		.30	.34	.26		.01	.01	
X_{11} Total canopy	F			5.06	8.36				
	b			.34	.36				
X_{12} Shrub barrier	F								
	b								
X_{13} Table density	F	10.08						16.16	4.63
	b	-2.56						-.11	-.09
X_{14} Table spacing	F					7.02			
	b					24.26			
X_{15} Proximity to parking	F	4.55					4.63		
	b	1.73					.09		
$X_{16/1000}$ Volume of use	F			8.21	11.03	4.92	11.02	3.66	
	b			1.30	1.30	2.20	.05	.02	
X_{17} Months of use	F								
	b								
X_{18} (Slope)^2	F								
	b								
Multiple regression coefficient R		.6324	.7165	.6758	.7066	.5237	.6811	.7038	.3349
R^2 x 100		39.99	51.34	45.67	49.93	27.43	46.39	49.53	11.22

Table 2. --Regression solution for 106 camping and picnicking sites on residual soils. Combinations of X variables yielding best solution for individual Y variables showing F values (best fit) and b values (sign and slope)

Independent variables		Y_1 Change in depth of A horizon	Y_2 Change in hydro-logic condition	Y_3 Bare ground-unplanned	Y_4 Bare ground-total	Y_5 Trees injured	Y_6 Degree of erosion	Y_7 Degree of root exposure	Y_8 Degree of vandalism
X_1 Depth of A horizon	F			4.24					
	b			-3.27					
X_2 Hydrologic condition	F		68.25			8.69	9.17		
	b		14.95			16.85	-.31		
X_3 Texture of A horizon	F						11.03	3.34	
	b						2.18	1.01	
X_4 Texture of B horizon	F	11.61	35.84					7.43	
	b	-34.75	-56.30					-.88	
X_5 Aspect	F	31.24	21.98	12.69	8.29				7.54
	b	22.10	16.86	15.46	9.94				-.41
X_6 Position on slope	F	5.29	12.99		5.00	12.40		15.76	
	b	11.32	18.80		14.90	60.50		.74	
X_7 Slope	F						4.51		
	b						.07		
X_8 Basal area of plot	F					4.44			
	b					1.90			
X_9 Conifer component	F					4.76			
	b					-.32			
X_{10} High canopy	F						7.23	25.33	
	b						.01	.01	
X_{11} Total canopy	F			25.82	27.54				
	b			.48	.43				
X_{12} Shrub barrier	F								
	b								
X_{13} Table density	F	11.68					3.71	13.95	4.46
	b	-2.78					-.09	-.11	-.09
X_{14} Table spacing	F					7.43			
	b					23.48			
X_{15} Proximity to parking	F	3.81							
	b	1.50							
$X_{16/1000}$ Volume of use	F			7.61	7.11	3.92	5.43		
	b			.46	.38	.95	.04		
X_{17} Months of use	F								
	b								
X_{18} (Slope)^2	F								
	b								
Multiple regression coefficient R		.6324	.7239	.6038	.6348	.4916	.5797	.6713	.2861
R^2 x 100		39.99	52.40	36.46	40.30	24.17	33.61	45.06	8.19

It is inevitable, indeed expected, that in regression analyses with a large number of independent variables that some significant F values (in this case somewhere between 5 and 10 percent) would occur by chance alone. This may be the case in a number of F values given in tables 1 through 6 and may explain several otherwise inexplicable irregularities. By and large, however, the multiple correlation coefficients are high--much higher in fact than expected. In most instances, it is obvious that the solutions are consistent and explainable. There appears to be a very low risk of inaccurate conclusions based on random error.

Table 3.--Regression solution for 53 camping sites on transported soils. Combinations of X variables yielding best solution for individual Y variables showing F values (best fit) and b values (sign and slope)

Independent variables		Y_1 Change in depth of A horizon	Y_2 Change in hydrologic condition	Y_3 Bare ground - unplanned	Y_4 Bare ground - total	Y_5 Trees injured	Y_6 Degree of erosion	Y_7 Degree of root exposure	Y_8 Degree of vandalism
X_1 Depth of A horizon	F								
	b								
X_2 Hydrologic condition	F								
	b								
X_3 Texture of A horizon	F								
	b								
X_4 Texture of B horizon	F								
	b								
X_5 Aspect	F						10.14		
	b						-2.19		
X_6 Position on slope	F			11.54	10.18			15.81	
	b			-17.26	-16.40			-1.28	
X_7 Slope	F								
	b								
X_8 Basal area of plot	F								
	b								
X_9 Conifer component	F								
	b								
X_{10} High canopy	F								
	b								
X_{11} Total canopy	F								
	b								
X_{12} Shrub barrier	F						3.10		
	b						-.05		
X_{13} Table density	F			101.42	86.74		13.05		
	b			-41.83	-39.12		-.98		
X_{14} Table spacing	F						7.72	7.63	
	b						.90	.65	
X_{15} Proximity to parking	F								
	b								
$X_{16}/1000$ Volume of use	F					7.60			
	b					13.60			
X_{17} Months of use	F								
	b								
X_{18} $(\text{Slope})^2$	F								
	b								
Multiple regression coefficient R				.8529	.8345	.3601	.6392	.5296	
$R^2 \times 100$				72.74	69.64	12.97	40.86	28.05	

Table 4.--Regression solution for 121 picnicking sites on transported soils. Combinations of X variables yielding best solution for individual Y variables showing F values (best fit) and b values (sign and slope)

Independent variables		Y_1 Change in depth of A horizon	Y_2 Change in hydrologic condition	Y_3 Bare ground-unplanned	Y_4 Bare ground-total	Y_5 Trees injured	Y_6 Degree of erosion	Y_7 Degree of root exposure	Y_8 Degree of vandalism
X_1 Depth of A horizon	F								
	b								
X_2 Hydrologic condition	F								
	b								
X_3 Texture of A horizon	F								
	b								
X_4 Texture of B horizon	F								
	b								
X_5 Aspect	F					5.92	9.48	5.14	
	b					10.94	-.46	-.26	
X_6 Position on slope	F			18.53	23.92	10.95			
	b			-72.33	-72.83	70.97			
X_7 Slope	F								
	b								
X_8 Basal area of plot	F						4.86	9.63	
	b						-.04	-.05	
X_9 Conifer component	F								
	b								
X_{10} High canopy	F			15.25	18.49				4.60
	b			.65	.64				.01
X_{11} Total canopy	F			8.00	10.66				12.68
	b			-.40	-.41				-.02
X_{12} Shrub barrier	F			8.44	8.66	7.34			
	b			.50	.45	-.48			
X_{13} Table density	F			13.87	3.74			5.21	
	b			-8.36	-3.85			-.17	
X_{14} Table spacing	F					3.50			3.46
	b					-4.97			.18
X_{15} Proximity to parking	F								
	b								
$X_{16/1000}$ Volume of use	F			3.70	3.55				
	b			.60	.52				
X_{17} Months of use	F						14.24		7.70
	b						-.33		-.24
X_{18} $(Scope)^2$	F								
	b								
Multiple regression coefficient R				.5995	.5897	.4774	.4230	.3761	.4281
R^2 x 100				35.94	34.77	22.79	17.89	14.15	18.33

Table 5. --Regression solution for 174 camping and picnicking sites on transported soils. Combinations of X variables yielding best solution for individual Y variables showing F values (best fit) and b values (sign and slope)

Independent variables		Y_1 Change in depth of A horizon	Y_2 Change in hydro-logic condition	Y_3 Bare ground-unplanned	Y_4 Bare ground-total	Y_5 Trees injured	Y_6 Degree of erosion	Y_7 Degree of root exposure	Y_8 Degree of vandalism
X_1 Depth of A horizon	F								
	b								
X_2 Hydrologic condition	F								
	b								
X_3 Texture of A horizon	F								
	b								
X_4 Texture of B horizon	F								
	b								
X_5 Aspect	F						17.11		
	b						-.46		
X_6 Position on slope	F			28.23	29.21		6.25	7.79	
	b			-38.58	-36.27		-.88	-.72	
X_7 Slope	F								
	b								
X_8 Basal area of plot	F						3.28	10.45	
	b						.03	.05	
X_9 Conifer component	F			5.65	5.99				
	b			.14	.13				
X_{10} High canopy	F			8.83	9.72				4.03
	b			.42	.40				.01
X_{11} Total canopy	F			4.18	4.66				9.81
	b			-.25	-.24				-.02
X_{12} Shrub barrier	F			6.73	6.42	5.95			
	b			.42	.38	-.42			
X_{13} Table density	F			26.74	12.04		7.33	4.78	
	b			-10.90	-6.76		-.25	-.16	
X_{14} Table spacing	F					9.74			4.47
	b					-7.31			-.19
X_{15} Proximity to parking	F					6.14			
	b					-1.76			
$X_{16}/1000$ Volume of use	F						3.77		
	b						.03		
X_{17} Months of use	F					3.40	9.22		10.39
	b					3.24	-.23		-.22
X_{18} $(\text{Slope})^2$	F								
	b								
Multiple regression coefficient R				.5749	.5359	.3785	.4265	.3472	.3649
$R^2 \times 100$				33.05	28.72	14.33	18.19	12.05	13.32

Table 6. --Regression solution for 280 camping and picnicking sites on all soils. Combinations of X variables yielding best solution for individual Y variables showing F values (best fit) and b values (sign and slope)

Independent variables		Y_1 Change in depth of A horizon	Y_2 Change in hydrologic condition	Y_3 Bare ground - unplanned	Y_4 Bare ground - total	Y_5 Trees injured	Y_6 Degree of erosion	Y_7 Degree of root exposure	Y_8 Degree of vandalism
X_1 Depth of A horizon	F								
	b								
X_2 Hydrologic condition	F								
	b								
X_3 Texture of A horizon	F								
	b								
X_4 Texture of B horizon	F								
	b								
X_5 Aspect	F						5.81		
	b						-.23		
X_6 Position on slope	F			8.18	4.34				
	b			-16.63	-10.63				
X_7 Slope	F								
	b								
X_8 Basal area of plot	F								3.08
	b								.02
X_9 Conifer component	F			9.77	9.36	9.30		5.48	5.51
	b			.14	.12	-.19		.003	-.004
X_{10} High canopy	F			29. 56	32.94		8.33	16.08	
	b			.38	.35		.01	.01	
X_{11} Total canopy	F						4.00		5.82
	b						-.01		-.01
X_{12} Shrub barrier	F								
	b								
X_{13} Table density	F			4.76		10.80	9.48	8.63	
	b			-2.34		-4.82	-.13	-.09	
X_{14} Table spacing	F								
	b								
X_{15} Proximity to parking	F					9.83			
	b					-2.75			
$X_{16/1000}$ Volume of use	F			6.70	5.26		7.32		
	b			.73	.57		.03		
X_{17} Months of use	F								8.43
	b								-.17
X_{18} $(\text{Slope})^2$	F								4.29
	b								.003
Multiple regression coefficient R				.4265	.4016	.3091	.3019	.3379	.2834
R^2 x 100				18.19	16.13	9.55	9.11	11.42	8.03

DISCUSSION

In the analysis on residual soils the relation between outside hydrologic condition (representing the comparable undisturbed site) and percent change in hydrologic condition is significant. It was evident both on picnic areas and all areas together (too few camping areas were taken for meaningful separate analyses) that increased recreation use is directly related to reductions in hydrologic condition, and that change in this respect is greatest among soils having a high natural capacity for water intake and storage.

Texture of the B horizon was associated with change in depth of A horizon and hydrologic condition. In both cases, increased particle size was significantly related to a decrease in change when subjected to recreation use. It might be conjectured that better internal drainage in the B horizon reduced erosion.

Depth of the A horizon, as might be expected, was also significantly related to table density--as expressed in tables per acre. As table density increased, depth of the A horizon became reduced. Distance to parking, which also showed a direct relation to change in A horizon, is unexplainable, and the low F value may have resulted from chance error or because more distant units are higher up on thinner soils.

On all residual soils, aspect and, less strikingly, position on slope were related to reduction in depth of A horizon and lowering hydrologic condition. On the more fertile sites the impact of recreation use appears to be more important because there was inherently more measurable damage that could be done.

In the results shown in table 2 for all residual soils, variable X_5 (aspect) in association with Y_3 and Y_4 (bare ground dependents) and X_6 (position on slope) and Y_4 and Y_7 (root exposure) disagree generally with the expected negative relations seen between X_5 and Y_6, and X_6 and Y_3, Y_4, Y_6, and Y_7 on transported soils (table 5). Although it is recognized that some increases in bare ground would be associated (normally) with higher position on slope (as seen in table 5), it was thought that this would be small in comparison to the effects of human use. It should be pointed out that the significant relations between X_5 and Y_3 and Y_4, and X_6 and Y_4 result in part from limited and probably nonrepresentative 13-unit sample of camping on residual soils. For this reason, these data were not tabulated but were totaled with the picnicking data in table 2. Perhaps more importantly, the conflicts seen here may result from a much heavier use at lower positions on slope because of unit location. Field observations tend to substantiate weaker results for transported soils and suggest that position on slope and very likely aspect may be important, and that with decreased fertility on thinner, drier, and higher soils there may be increased damage.

The fairly consistent high relation between damage to trees, Y_5, and position on slope, X_6, may, in part, result from less use on upslope units by location than lower units which are usually closer to roads. This may also result from a probable relation between position on slope and species composition, with the species occurring at higher positions on slope somewhat less vulnerable to damage.

Other related variables common on all soils offer important relationships. For all areas tested the most important relations were those associated with bare ground, erosion, and tree damage. Degrees of root exposure and vandalism apparently were only weakly related to principal X variables and, accordingly, warrant only passing mention in this discussion.

Quite likely the most important relationships seen in this analysis for all sites and soils were those between the amount of high canopy and bare ground, erosion, and root exposure. In all cases an expected and predictable detrimental change in amount of understory and damage to soil through erosion was associated with an increase in crown closure (high canopy).

The negative and perhaps unexpected relation between total canopy and bare ground value in picnic areas on transported soils and both areas on transported soils probably results from high canopy values associated with highly uneven, broken crowns. It appeared that there were fewer two-storied stands on residual soils than on transported soils and actually high and total canopy were essentially one. On transported soils the frequent presence of two-stand conditions was apparently reflected in total canopy and negative bare ground relations where breaks in stands actually improved conditions for development of ground cover. This effect of canopy breaks apparently drops out on all sites and soils and only high canopy remains important. Further, increase in the ratio of conifers to hardwoods is associated with reduction in ground cover and increased root exposure. Quite likely, this association is linked generally to the distribution of conifers on thinner soils.

Acres per table were consistently associated with damage, as might be expected; apparently table spacing was less important. It is conjectured that distance between tables was weak or contradicting, principally because spacing is generally held to specifications along roads and loops. Furthermore, it is suspected that what is seen here in the association between table density and damage is really the result of increased table density to accommodate increasing demand which in turn is associated with heavier use damage. Observations confirmed the thesis that virtually all damage is localized, and only where tables are very close together would spacing or density be a problem. This suggests that up to a point (perhaps aesthetically rather than biologically) table spacing may be of only minor importance in controlling site damage. This is further supported by the expected relation which was seen between volume of use and site degradation as expressed in decline of ground cover and site erosion with increase in volume of use.

Distance to the nearest parking facility was importantly, though not strongly, associated with site degradation for all areas. Although this did not result in significant relation to reduction in ground cover and erosion, tree damage was inversely related to distance and the latter was thought to be an important, controlling factor.

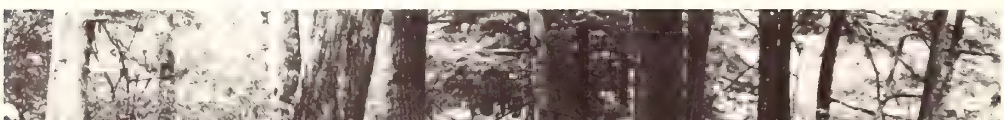
Shrub barrier, expressed as square footage of the plot protected from use by shrubs, was related to damage on picnicking sites. As the amount of shrub barrier increased, so did damage. It seems safe to conclude that this result was produced by a compression of use; it is also possible that this relationship resulted from an active program of shrub planting where heavier traffic was damaging the site. In contrast, an inverse relation between increased shrub barrier and reduction in tree injury was seen.

Some form of tree growth in developed sites is generally considered desirable.

Information on the effects of recreation use on developed sites was gathered from 280 family units in 42 campground and picnic sites in the Southern Appalachians.

Heavy use and damage to soil and vegetation were closely confined to a small area immediately surrounding the picnic table.

The amount of bare soil and associated damage in the immediate vicinity of a picnic table was related to the amount of use, but was also related directly to the amount of overstory canopy.



Failure to maintain nearly complete ground cover in developed sites results in soil loss and root exposure.

Reduced depth of the A horizon was most striking in highly fertile areas with poor drainage in the B horizon.

The presence of heavy shrub growth in the immediate vicinity of trees would have provided protection and prevented heavy injury seen in this exposed situation.

Although design and layout may have less control over vandalism than over other types of damage, vandalism may be reduced by modifications in site plans.

MANAGEMENT IMPLICATIONS

A number of relations seen in this study and analysis may have important management implications. As enumerated, they may suggest some management guides or revision in area treatment policy.

1. Although there are conflicts in the data, it appeared generally that more fertile sites were better able to withstand use and maintain vegetation.

2. Slope in the immediate vicinity of the picnic table or family unit appears to be less important than many other variables, and moderately steep slopes in local areas within a site may be acceptable.

3. Although no absolute values were obtained in this study, it was evident that dense tree canopies adversely and importantly limit growth of ground level species that protect the site. It might be inferred, then, that for most areas canopy reduction could produce important understory regrowth and decrease area soil losses.

4. The findings in this study suggest that, because individual unit use is closely confined to the picnic table, table spacing is a minor factor (aesthetics excepted). Further, the ratio of tables per acre, though significant, was probably of limited direct importance at reasonable densities. This suggests that closely spaced units used on a rotation basis, for example by shifting tables, might be useful in reducing site damage.

5. The amount (square footage) of ground effectively protected by shrub growth from human use was directly related to increases in site degradation. Apparently, shrub barrier is very effective in protecting local areas and reducing tree damage but must be used judiciously to prevent abnormal compression of use.

6. It appears that layout of parking facilities does control area use and that parking facilities can be distributed to effect uniform use that may result in lessened impact on local areas. Although distance between parking areas and family units was not significantly related to soil and vegetation losses, tree damage (as a measure of degradation) decreased as distance to parking increased.

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